Chapter 11

Nutrition and Childhood Lead Poisoning

Content:

Introduction

Nutrition is an important factor in the prevention and treatment of lead toxicity. The nutrients received from certain foods and supplements help protect the individual from lead in the environment and from lead stored in the bones. For example, a child with an adequate iron status will absorb less lead than a child with iron deficiency. A pregnant woman who has a low dietary calcium intake may release stored lead from her bones into her blood, where it becomes available to the fetus.

The role of nutritional status in altering susceptibility to lead is well recognized. Overall, a child or adult in excellent nutritional status is partially protected from lead toxicity. Conversely, a compromised nutritional state makes one more susceptible to lead toxicity. Sound nutritional guidelines for children are compatible with recommendations for lead poisoning prevention.

Sources of Nutritional Lead Exposure

Water

Water is the main source of dietary lead. Infants and young children may consume large quantities of water in formula and other liquids.

Lead levels of drinking water can increase when the water is heated and/or remains in contact with lead-containing plumbing for extended periods of time, especially in areas where water is corrosive (soft). Water can be the source of lead in reconstituted juices and beverages, foods boiled or prepared using large amounts of lead contaminated water.

Because of the volume consumed, formula made with lead-contaminated water is especially dangerous to infants. Formula high in lead can result from using water that was 1) first-draw morning water; 2) drawn from the hot water tap; 3) boiled longer then 10 minutes (causing lead to concentrate); and/or 4) boiled in lead-containing vessels.

To minimize lead exposure from water, use only water from the cold water tap. If tap has not been used for 6 hours or longer, run the tap water for 2-3 minutes or until icy cold before beginning formula or food preparation. If lead level in tap water is of concern, bottled water should be used for mixing formula. If water for formula is boiled, time carefully and limit boiling time to 5 minutes.

Lead contaminated water is rarely identified as a source of lead in Wisconsin children, the primary cause being deteriorated lead-based paint. However, to rule out lead as a source of exposure, water testing can be done through the Wisconsin State Laboratory of Hygiene (608-262-1293).

Food Containers

Containers with elements of lead can contaminate food that is cooked, stored or transported in the container. Lead-soldered cans, lead glazed pottery, cracked or chipped pottery, and leaded crystal can all be sources of lead in food. The longer the food or beverage is exposed to a leaded container, the more contaminated it will become. Hot and/or acidic liquids also promote the leaching of lead from containers.

While the U.S. has prohibited lead soldering of food containers and regulates lead content in pottery glaze, imported foods or dishes may continue to be a source for lead contamination of food.

Supplements
Natural calcium supplements such as bonemeal, oyster shells, and dolomite can also be contaminated with lead. Pregnant women should especially be cautious of these sources of calcium supplement.

Soil
Lead can enter the food chain when vegetables and fruits are grown in soil that is contaminated with lead. Lead-contaminated soil is most often found next to old painted buildings, near roadways, near manufacturing and renewal/demolition sites, and in old orchards (from the use of fertilizers/pesticides containing lead). Leafy and root vegetables are most likely to become lead-contaminated because of their high water content, large surface exposure, and direct contact with the soil. Dust from traffic, remodeling, demolition, and manufacturing can contaminate garden produce, food preparation surfaces, and foods that are not protected from dust by covers or wrappings.

Lead from soil and dust can also be ingested by infants and very young children who mouth objects or their hands. Using a pacifier helps prevent the hand-to-mouth transfer of lead especially when playing outdoors and in other environments that are likely to be lead-contaminated. Since children often drop pacifiers, they should be cleaned frequently to remove any lead dust contamination. Careful handwashing before eating and after play can decrease lead exposure from these sources.

Diet and Eating Patterns Minimize Lead Toxicity

The timing and types of nutrients in the diet can assist in decreasing the absorption of lead into a child's body. Fortunately, these recommendations are also part of sound nutritional counseling.

Regular Meals and Snacks Decrease Lead Absorption
Stomachs that are full are less able to absorb lead. Gastrointestinal (GI) absorption of lead is 3 to 4 times greater during periods of fasting than during periods of feeding. Infants, young children, and pregnant women should consume well-balanced meals and snacks at regular intervals during waking hours to help prevent lead absorption. Infants and young children need to be fed at least every 3 to 4 hours.

Calcium
The more calcium a child has, the less lead is retained by their body. Calcium and lead seem to compete for absorption in the GI tract and for storage sites in the bones. Remobilization and subsequent elevation of blood lead levels occurs most readily when dietary calcium intakes are low and/or when calcium needs are increased, as during pregnancy, periods of bone growth, lactation, and following bone fractures. A combination of calcium and phosphorus in the diet further reduces lead absorption, making plant sources of calcium especially effective in preventing lead absorption.

Iron

Iron deficient individuals absorb 2 to 3 times more lead than individuals with adequate levels of blood iron. Iron and lead interact and compete in heme synthesis. Even slight decreases in hematocrit allow increased lead absorption. In addition, more severe anemia occurs when both lead toxicity and iron-deficient diets are present. Iron supplementation lowers lead levels in children and lead-exposed women. See the section entitled Medical Management of Lead Poisoned Children for more information on the diagnosis, affects, and treatment of anemia associated with lead poisoning. Diets rich in Vitamin C enhance iron absorption.

Figure 11.1

Foods that Reduce Lead Absorption are those rich in . . .

Calcium: milk, cheese, yogurt, kale, collards, turnip greens, canned salmon. sardines with bones

Iron: lean meats and poultry, seafood, cereals and breads fortified with iron, peanut butter, nuts, dried beans & peas, raisins, prunes, prune juice, greens such as broccoli and spinach

Vitamin C: tomatoes, oranges and grapefruits and juices, juices fortified with vitamin C, strawberries, kiwi, green peppers, watermelon, cantaloupe, potatoes

Offer more of these!

Other nutrients can help the body to reduce the toxic effects of lead that is absorbed. Zinc, thiamin, and vitamin E all play this role. Families may be unfamiliar with foods that contain these nutrients.

Figure 11.2

Foods Rich In Zinc, Vitamin E, Thiamin . . .Reduce the Toxic Effects of Lead

Zinc	Vitamin E	Thiamin
Lean red meats	Vegetable oils	Whole grain foods
Eggs	Wheat germ	Organ meats
Fish & seafood Nuts		Lean pork
Milk & cheese		Legumes

Offer more of these!

In animal studies, unbalanced diets with high levels of fat or protein resulted in increased absorption of lead, while moderate dietary intakes of protein and fat appear to help prevent lead toxicity. Limiting high fat foods in a diet contributes to overall health, as well as helping in lead poisoning.

A balanced diet containing a variety of foods provided at regularly scheduled meals and snacks will assure optimal nutritional status for the children and other family members.

Figure 11.5

High Fat Foods . . . Increase Absorption of Lead

Shortening, lard, oil	Margarine, butter	Mayonaise
Fried foods	Chips & other fried snacks	Pastry, donuts
Lunchmeats, hot dogs	Candy bars	Sausage, bacon

Offer less of these!

Iron Deficiency and Lead Poisoning

Iron deficiency can enhance lead absorption and often co-exists with lead poisoning. In addition, research indicates that iron deficiency in young children can be an independent neurotoxin, as well as enhancing the effects of lead poisoning on the central nervous system.

Adequate iron intake lowers lead absorption, and should be considered a primary tool in decreasing the effects of exposure to lead hazards. While the effect of lead on red blood cell production rarely occurs until BLLs reach around 40μg/dL, low iron stores promote absorption of lead at any blood lead level. Over half of US children 1-2 years of age have daily iron intake below recommended amounts. When exposed to lead hazards, these children may see the lasting effects on cognitive development due to both iron deficiency in infancy and the long lasting negative effects due to lead.

All children with BLLs $\geq$10μg/dL should be evaluated for iron deficiency. Serum iron and iron binding capacity are the tests of choice, as they are the most sensitive indicators of iron status. If iron deficiency is diagnosed, treatment should begin along with treatment of the lead exposure. *Note: Children receiving BAL (dimercaprol) as a chelating agent should not be treated for iron deficiency until the drug therapy is completed.*

Screening for Lead Poisoning & Education in WIC Clinics

Because of the close tie between nutrition and lead poisoning, and because children regularly receive a finger stick as part of the WIC (Women, Infants, and Children Nutrition Program) certification, WIC clinics are opportune sites for blood lead testing and nutrition counseling related to lead poisoning. For the last 3 years, WCLPPP has worked closely with the Wisconsin WIC program to facilitate blood lead testing at WIC project sites.

Many local WIC sites offer blood lead testing in collaboration with local health departments and managed care organizations. An analysis of BLLs of children enrolled in WIC indicates they have a higher incidence of lead poisoning then non-WIC enrollees.

The state WIC and WCLPPP programs have collaborated to modify the functions of the WIC data collection system (DAISy) to improve tracking of blood lead tests of children coming in for recertification. There are non-mandatory fields in DAISy that,

once activated, allow WIC staff to enter the date and result of a lead test, and if it was drawn at the WIC clinic. Once that data is entered for a child, DAISy will flag the child at the next recertification if they are due for a lead test.

The nutrition education card series developed by WIC includes the care entitled "Eating Right: Preventing Childhood Lead Poisoning") gives nutrition and other tips that decrease lead toxicity. WIC and local health agencies can order it from the Department of Health and Family Services Forms Center (POH 4968) form using DMT-25. See Chapter 6 for further information on educational materials related to nutrition and lead poisoning.

It is important to note that federal limitations do not allow the use of federal WIC funds to be used to obtain blood lead tests. LHDs must negotiate with the WIC project on compensation for time and training required to include lead testing in WIC clinic flow.

References

Andrews, K.; Savitz, D.; Hertz-Picciotto, I. "Prenatal Lead Exposure in Relation to Gestational Age and Birth Weight: A Review of Epidemiologic Studies." *American Journal of Industrial Medicine* 26, 1994, pp. 13-32.

Baldini, M.; Coni, E.; Mantovani, A.; Stacchini, A.; Zanasi, F. "Effect of Unbalanced Diets on Long Term Metabolism of a Toxicant 1. Lead in Rats: Preliminary Note." *Food Add and Contaminants* 6 (1), 1989, pp. 117-124.

Reichlmayr Lair, A.M.; Kirchgessner, M. Edited by Earl Friedman. "Lead." *Biochemistry of the Essential Ultratrace Elements*. New York, NY: Plenum Press, 1984, pp. 367-387.

Frisancho, A. R.; Ryan, A. S. "Decreased Stature Associated With Moderate Blood Lead Concentrations in Mexican American Children." *American Journal of Clinical Nutrition*. 54 (3), September 1991, pp. 516-519.

"Lead in 'Natural' Calcium Pills Still Causes Concern." *Tufts Univ Diet Nutr Letter*. 5 (9), November 1987, pp. 2.

Lucas, S.; Sexton, M.; Langenberg, P. "Relationship Between Blood Lead and Nutritional Factors in Preschool Children: A Cross-Sectional Study." *Pediatrics* 97(1), 1996, pp. 74-78.

Mahaffey, K. "Environmental Lead Toxicity: Nutrition as a Component of Intervention." *Env Health Pros.* 89, 1990, pp. 75-78.

Mahaffey, K. "Nutrition and Lead: Strategies for Public Health." *Env Health Perspectives* 103 (Suppl 6), 1995, pp. 191-196.

"The Pollutants That Matter Most: Lead, Radon, Nitrate." *Consumer Report. Consumer Union U.S.* 55 (1), January 1990, pp. 30-32.

Sargeant, J. "The Role of Nutrition in the Prevention of Lead Poisoning in Children." *Pediatric Annals* 23, November 1994, pp. 636-642.

Schwartz, J.; Angel, C.; Pitcher, H. "Relationship Between Childhood Blood Lead Levels and Stature." *Pediatrics* 77 (3), March 1986, pp. 281-288.

Shannon, M.; Graef, J. W. "Lead Intoxication: From Lead-Contaminated Water Used to Reconstitute Infant Formula." *Clin Pediatr*. 28 (8), August 1989, pp. 380-382.

Watson, W. S.; Morrison, J.; Bethel, M. I. F.; Baldwin, N. M.; Lyon, D.T. B.; Dobson, H.; Moore, M. R.; Hume, R. "Food Iron and Lead Absorption in Humans." *An J Clin Nutr.* 44 (2), August 1986, pp. 248-256.

Yip, R. "Iron Deficiency and Childhood Lead Poisoning." *Functional Significance of Iron Deficiency.* Ed. Cyril O. Enwonwo. Meharry Medical College, Fall 1990.

Revised 10/9/2003